

Effects of mobile mindfulness training on mental health of employees

A CONSORT-compliant pilot randomized controlled trial

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Abstract

Background: Employee stress and well-being affect organizational efficiency and productivity, as well as physical and psychological health of employees. Mindfulness is believed to reduce stress, prevent diseases, and promote well-being. Mindfulness has been used as the main component of various smartphone-based healthcare applications. Previous studies have suggested that mindfulness applications have a positive effect on employee stress and mental health. However, relatively few randomized controlled trials have examined the effectiveness of mindfulness applications on employees. This study aims to evaluate whether mobile mindfulness training (MMT) as a stress self-management tool improves employees' perceived stress, subjective well-being, and Mibyeong, a condition that is not a disease but shows obvious health abnormalities.

Methods: Participants were recruited through advertisements displayed at 3 workplaces, including a patent attorney's office, a construction company, and a public relations firm. A total of 45 employees were randomly assigned to 1 of 2 groups: the MMT group (Group A) receiving smartphone application-based mindfulness training, and a wait-list control (WLC) group (Group B), who received no intervention. Group A employees conducted MMT following daily and event guidelines for 4 weeks. In contrast, Group B employees did not receive any intervention in that time. The outcome variables were perceived stress, subjective well-being, and Mibyeong. Surveys were conducted at baseline, post-intervention, and follow-up (fourth week post-intervention).

Results: Demographic characteristics and baseline assessments were not significantly different between the 2 groups. The results of this study revealed that subjective well-being and Mibyeong were significantly improved in the MMT group compared with the WLC group. Moreover, this improvement was maintained up to at least 4 weeks later. However, perceived stress was not significantly reduced in the MMT group compared to the WLC group.

Conclusion: Four weeks of MMT improved the subjective well-being and Mibyeong of employees. However, further studies are required to investigate the effect of MMT on other areas of mental health.

Abbreviations: COMOSWB = Concise Measure of Subjective Well-Being, HRV = heart rate variability, MBI = Mibyeong Index, MMT = mobile mindfulness training, PSS = perceived Stress Scale, RCT = randomized controlled trial, WLC = wait-list control.

Keywords: employee, meditation, Mibyeong, mindfulness, smartphone application, stress, subjective well-being

1. Introduction

Work stress is defined as a phenomenon where the work environment and personal factors interact to negatively affect the psychological and physiological functions of employees.^[1] Excessive work-related stress not only negatively affects personal health, but also lowers work motivation, increases mistakes and accidents, and consequently reduces organizational

efficiency and productivity.^[2] According to previous studies, chronic exposure to stress at work causes physical and psychological disorders, increases job dissatisfaction, and reduces job performance.^[3–6] For this reason, companies have recently become increasingly interested in the stress and health of their employees, and common interventions to manage employee stress include cognitive behavioral therapy, meditation, and relaxation.^[7]

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According to the World Health Organization, health is defined as a state of physical, psychological, and social well-being beyond the absence of disease. Similarly, positive psychology aims at psychological well-being, such as the enhancement of life satisfaction and happiness, beyond the absence of psychological disorders or maladjustment.^[8] According to previous studies, well-being and happiness function as protective factors to maintain physical and psychological health,^[9] and further improve the job performance of employees.^[10]

In the mid-1980s, N. Buchmann declared “sub-health” a new condition that is not a disease but shows obvious health abnormalities, and is considered similar to Mibyeong in Korean and Chinese medicine.^[11] Mibyeong is a condition that is not diagnosed as a specific disease but shows clear abnormal symptoms in the body, which is a stage before the development of a disease.^[11,12] Since Mibyeong is not classified as a disease, it is seldom diagnosed in hospitals, and is therefore a condition that is often mismanaged.^[13] However, since Mibyeong directly affects quality of life and has the potential to act as an early risk factor for various chronic diseases, proper management should be performed at the preventive level.^[11–13]

Considered together, health is defined to include not only the absence of dysfunctional conditions, but also the prevention of disease and promotion of well-being. Recently, various smartphone-based healthcare applications have been developed to address this comprehensive and holistic level of health.^[14] Smartphone-based interventions can provide high-level training without geographical constraints, and can provide customized training suitable for individuals at reduced economic cost.^[15] Furthermore, although it is difficult to control for individual differences in how these interventions are used, it is easy to standardize how interventions are delivered, and therefore, they can be as effective in health management as well-designed offline training.^[15] Several previous studies have found that digital healthcare applications not only reduce psychological symptoms, but also prevent diseases and promote well-being.^[16–18]

Mindfulness is the non-judgmental awareness of the present moment and a unique attention cultivated through the practice of meditation. Mindfulness allows us to accept the experience of the present moment as it is, helps us make a deliberate choice different to the dysfunctional automatic reaction, and further improves our mental health.^[19,20] According to previous studies, mindfulness reduces stress and anxiety, prevents depression, and improves well-being.^[21–24] Mindfulness is actively used to improve the mental health and performance of employees beyond the clinical setting. Previous studies have shown that mindfulness reduces employee stress and improves well-being and job performance.^[25–27]

Due to the benefits on mental health, mindfulness has recently been used as core content in several mobile healthcare applications such as Headspace and Calm which cultivate mindfulness, and through several clinical studies, it has been found that they reduce users’ stress, depression, and anxiety, and further improve their quality of life.^[18,28–31] However, previous randomized controlled trial (RCT) studies on the effectiveness of smartphone-based mindfulness training have mostly been conducted with students or the general public, and there are relatively few RCT studies on employees.^[18] Moreover, previous studies on employees are limited in that they do not deal with holistic health, such as disease prevention and happiness.^[32,33]

1.1. Objectives

The primary objective of this study was to examine whether a 4-week mobile mindfulness training (MMT) program improves the mental health of employees. This study investigated the significance of the difference by comparing the measured values of continuous variables. The primary hypotheses of this study were as follows: MMT further reduces scores of the Perceived Stress Scale (PSS) compared to wait-list control (WLC) after

4 weeks. MMT further increases scores of the Concise Measure of Subjective Well-Being (COMOSWB) compared to WLC after 4 weeks. MMT further reduces scores of the Mibyeong Index (MBI) compared to WLC after 4 weeks.

The secondary objective of this study was to examine the follow-up effect of MMT on the mental health of employees. The secondary hypotheses of this study were as follows: In MMT, scores of the PSS at follow-up (fourth week post-intervention) are lower than those at baseline and do not differ from that at post-intervention. In MMT, scores of the COMOSWB at follow-up are higher than those at baseline and do not differ post-intervention. In MMT, scores of the MBI at follow-up are lower than those at baseline and do not differ post-intervention.

2. Methods

2.1. Study design

This study was a RCT that investigated the effects of MMT on the mental health of employees. The participants were randomly allocated to either the MMT group (Group A) or the WLC group (Group B). The intervention was conducted over 4 weeks. Outcome variables were measured at baseline, post-intervention, and follow-up (fourth week post-intervention). Participants took part in the study for 8 weeks, from the baseline survey to the follow-up survey. This study did not restrict employees’ participation in other well-being programs.

2.2. Participants

This study was conducted at the Kyung-Hee University Korean Medicine Hospital in Gangdong. Participants were recruited through advertisements displayed at 3 workplaces, including a patent attorney’s office, a construction company, and a public relations firm. Forty-five participants were recruited for this study. The inclusion criteria were as follows:

1. Age > 20 years
2. Employees who subjectively reported “I am stressed.”

Participants who did not meet the inclusion criteria were excluded from the study, and there were no other exclusion criteria.

The minimum sample size was calculated using G* Power.^[34] A value of 0.06 indicating a medium effect size and a significance level of 0.05 were set, and the power was applied as 0.80. The calculation indicated that a minimum of 34 participants were required, with a minimum of 17 participants per group. According to previous studies on application-based mindfulness interventions,^[35,36] the dropout rate of the intervention group was approximately 7% to 23%. Considering the dropout rate of 20%, the maximum sample size was 23 per group. All participants provided written informed consent prior to participating in the study.

2.3. Intervention

2.3.1. MMT (Group A). The MMT group (Group A) was provided with a smartphone application, InMind, for 4 weeks after the baseline survey. InMind is a mobile healthcare application that provides various mindfulness-based programs to cope with stress. InMind was developed in Korea and is available in Korean as well as English and Japanese. InMind provides a stress self-management process in the following order: measurement and analysis of heart rate variability (HRV) and recommendation of customized contents. Participants were asked to follow daily and event guidelines while using InMind (Table 1).

There were 3 daily guidelines, and the employees were asked to follow them every day while using InMind for 4 weeks. Every

Table 1
Guideline for mobile mindfulness training.

Guideline		
No.	Daily	Event
1	In the morning, 1) Measure HRV (1 min) 2) Practice the recommended content (10 min)	When you experience a stressful situation: 1) Report subjective stress (0–10) 2) Measure HRV (1 min)
2	At night, 1) Measure HRV (1 min) 2) Write emotional diary (10 min)	3) Practice the recommended content (10 min) 4) Report subjective stress (0–10)
3	At any time, 1) Practice “2-wk meditation course” (10 min)	5) Measure HRV (1 min)

HRV = heart rate variability.

morning, participants completed HRV measurement, after which they practiced the recommended content provided by InMind. Contents, such as breathing meditation, rethinking, or healing sounds, are recommended according to the current HRV level, and each piece of content has a duration of approximately 10 minutes. Second, every night, the participants completed another HRV measurement and then wrote an emotion diary. An emotion diary is an exercise in which one draws the emotions experienced during the day in the form of emoticons and names them. Third, the participants practiced the guided meditation included in the “2-week meditation course” in order, once daily at any time. The “2-week meditation course” includes sitting meditation, body scan, mindfulness yoga, eating meditation, and walking meditation, among others. Each has a duration of approximately 10 minutes. The intervention lasted for 4 weeks.

The event guidelines were recommended to be followed whenever participants experienced a stressful situation, and they were asked to proceed in a specific order. When faced with a stressful situation, participants first reported their subjective stress on a scale of 0 (no stress at all) to 10 (very high stress). After measuring HRV, they were required to practice the recommended content provided by InMind. After practicing the recommended content, the participants reported subjective stress and measured HRV again.

After using InMind for 4 weeks, a post-intervention survey was conducted. A follow-up survey was conducted in the fourth week after the post-intervention survey. The study was terminated after the completion of the follow-up survey. KRW 50,000 (approximately 40 USD) was paid as a reward for completing each survey.

2.3.2. WLS (Group B). Unlike Group A, the WLC group (Group B) did not receive any intervention for 4 weeks after the baseline survey. After completing the post-intervention survey, in consideration of ethical equity, the WLC group also received InMind for 4 weeks, and all procedures were the same as for Group A. The study was terminated after the completion of the follow-up survey. KRW 50,000 (approximately 40 USD) was paid as a reward for completing each survey.

2.4. Randomization

All participants were randomly allocated to either the MMT or WLC group. A random number table of 20×40 cells was generated by a computer. When a random number table is generated, a random cell is selected and then read by 2 digits to the right. If a participant’s ID matched, the participant with that ID was allocated to the MMT group. The allocation ratio between the MMT and WLC groups was 1:1. The investigator (S-IL) enrolled the participants and assigned IDs in the order of

enrollment. The investigator (S-IY) generated a random number table and randomly assigned the participants.

2.5. Outcomes

2.5.1. Perceived Stress Scale. The Korean version of the PSS was used in this study.^[37] Perceived stress comprises 2 subfactors: negative perception and positive perception. The positive perception items were counted using inverse scoring. This is a self-reported 5-point Likert scale consisting of 10 items. The higher the score, the higher the perception of stress during normal times. Perceived stress was assessed at baseline, post-intervention, and follow-up.

2.5.2. Concise Measure of Subjective Well-Being. The COMOSWB was used to measure subjective well-being,^[38] which consists of 3 subfactors: life satisfaction and positive and negative emotions. Negative emotion items are counted using reverse scoring. This scale is a self-reported 7-point Likert scale consisting of 9 items. The higher the score, the higher the subjective well-being of an individual. Subjective well-being was assessed at baseline, post-intervention, and follow-up.

2.5.3. Mibyeong Index. The MBI was used to measure Mibyeong.^[12] Mibyeong is a condition that is not diagnosed as a specific disease but shows clear abnormal symptoms in the body and is a stage before the development of a disease.^[11,12] Mibyeong comprises 7 subfactors: fatigue, pain, sleep disturbance, indigestion, anxiety, anger, and depression. Each subfactor comprises 3 items: severity of symptoms, duration of symptoms, and degree of recovery after rest. This scale is a self-reported 7-point Likert scale consisting of 21 items. The higher the score, the more severe the Mibyeong of the individual. Mibyeong was assessed at baseline, post-intervention, and follow-up.

2.6. Statistical analysis

In this study, we conducted an intention-to-treat analysis. Statistical analyses were performed using SPSS software (ver. 22.0; IBM corp., Armonk, NY). First, to investigate the effect of MMT on the mental health of employees, a 2 (group: MMT vs WLC) × 2 (survey time: baseline vs post-intervention) repeated measures analysis of variance for perceived stress, subjective well-being, and Mibyeong was conducted. For the simple main effect analysis, we performed a paired *t* test comparing baseline and post-intervention outcomes for each group. Second, a paired *t* test comparing follow-up and baseline outcomes and follow-up and post-intervention outcomes was respectively performed in the MMT group to examine the follow-up effects of MMT. Because the WLC group received additional interventions for ethical equity, follow-up evaluation of the WLC group was not used in the analysis.

2.7. Ethics approval

This study was approved by the Institutional Review Board of Kyung-Hee University Oriental Medicine Hospital in Gangdong (KHNMCOH 2021-10-008-006).

3. Results

Participant recruitment for this study was conducted between November 24, and December 16, 2021. Forty-five participants were enrolled and randomly allocated to either MMT (n = 22) or WLC (n = 23) groups. One participant in the WLC withdrew before the study ended. One MMT participant did not respond to post-COMOSWB, and another MMT participant did not respond to follow-up-COMOSWB. Missing data were imputed

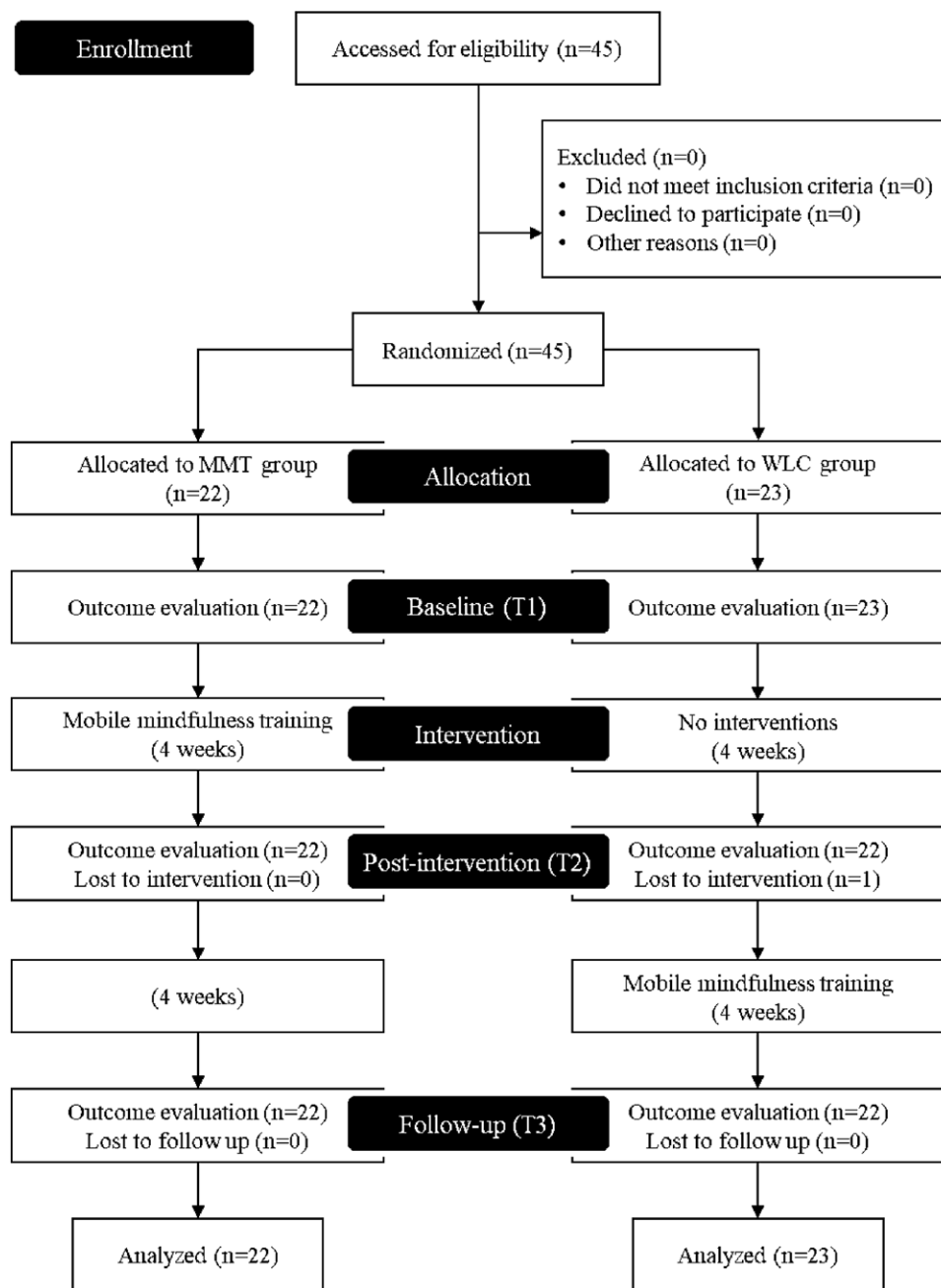


Figure 1. Study flow diagram. The flow diagram illustrates the study's process. The study proceeded sequentially, in the direction of the arrows. The MMT group received InMind, an application that provided MMT. The outcomes evaluated were as follows: perceived stress, subjective well-being, and Mibyeong. Mibyeong is a condition that is not diagnosed as a specific disease, but shows clear abnormal symptoms in the body. Because the WLC group received additional interventions for ethical equity, follow-up evaluation of the WLC group was not used in the analysis. MMT = mobile mindfulness training, WLC = wait-list control.

using the expectation-maximization algorithm. Therefore, 45 participants were finally analyzed (Fig. 1). The demographic characteristics of the participants are presented in Table 2. No significant differences were found in terms of age, sex, PSS, COMOSWB, or MBI at baseline ($P_s > .10$).

3.1. Perceived stress

The group \times time interaction was not significant for perceived stress ($F(1, 43) = 3.36, P = .074$). This suggests that changes in perceived stress over time were similar between the 2 groups. As a result of the simple main effects analysis, there was no significant difference in perceived stress between T1 and T2 in either group (MMT: $t(21) = 1.24, P = .229$; WLC: $t(22) = -1.36, P =$

$.189$). As a result of the paired t test to examine the follow-up effect, the difference between T1 and T3 was not significant for MMT ($t(21) = .98, P = .337$), and the difference between T2 and T3 was not significant for MMT ($t(21) = -.05, P = .958$). This suggests that the 4-week MMT did not improve the perceived stress. The results and statistical analyses are presented in Tables 3 and 4.

3.2. Subjective well-being

The group \times time interaction was significant for subjective well-being ($F(1, 43) = 4.23, P = .046$). This suggests that the changes in subjective well-being over time differed between the 2 groups. As a result of the simple main effects analysis, MMT

significantly increased subjective well-being in T2 compared with T1 ($t(21) = -2.54, P = .019$). In contrast, WLC did not increase subjective well-being in T2 compared with T1 ($t(22) = .47, P = .643$). This suggests that 4-week MMT increased subjective well-being. As a result of the paired t test to examine the follow-up effect, MMT significantly increased subjective well-being in T3 compared with T1 ($t(21) = -2.41, P = .025$). In contrast, the difference in subjective well-being between T2 and T3 was not significant ($t(21) = -.31, P = .760$). This suggests that the 4-week MMT not only increased subjective well-being,

but also maintained improved subjective well-being for 4 following weeks. The results and statistical analyses are presented in Tables 3 and 4.

3.3. Mibyeong

The group \times time interaction was significant for Mibyeong ($F(1, 43) = 11.13, P = .002$). This suggests that the changes in Mibyeong over time differed between the 2 groups. As a result of the simple main effects analysis, MMT significantly reduced Mibyeong in T2 compared with T1 ($t(21) = 3.86, P < .001$). In contrast, there was no significant difference between T1 and T2 in the WLC ($t(22) = -.99, P = .335$). This suggests that the 4-week MMT improved the Mibyeong symptoms. As a result of the paired t test to examine the follow-up effect, MMT significantly reduced subjective Mibyeong in T3 compared with T1 ($t(21) = 4.55, P < .001$). In contrast, the difference in Mibyeong between T2 and T3 was not significant ($t(21) = 1.06, P = .301$). This suggests that the 4-week MMT not only improved Mibyeong symptoms, but also maintained improved Mibyeong symptoms until 4 weeks later.

The group \times time interaction was significant for depression, anger, and anxiety ($P_s < .016$). This suggests that the changes in depression, anger, and anxiety over time differed between the 2 groups. As a result of the simple main effects analysis, MMT significantly reduced depression, anger, and anxiety in T2 compared with T1 (depression: $t(21) = 2.43, P = .024$; anger: $t(21) = 2.65, P = .015$; anxiety: $t(21) = 2.87, P = .009$). In the case of depression, anger, and anxiety, there was no significant difference between T1 and T2 in the WLC ($P_s > .096$). This suggests that the 4-week MMT improved depression, anger,

Table 2
Demographic characteristics and baseline outcomes (SD) in 2 groups.

	MMT (n = 22)	WLC (n = 23)	P value
Age	34.86 (6.61)	39.13 (11.78)	.141
Sex (female %)	59.1%	39.1%	.181
PSS	28.05 (4.87)	27.30 (4.06)	.582
COMOSWB	38.91 (7.12)	41.87 (5.07)	.114
MBI	67.18 (18.05)	63.61 (20.76)	.542
Fatigue	11.91 (4.17)	12.39 (3.12)	.662
Pain	9.09 (3.93)	9.52 (4.93)	.748
Sleep disturbance	9.45 (5.05)	9.04 (5.50)	.795
Indigestion	8.77 (4.15)	8.04 (3.25)	.514
Depression	9.09 (5.26)	8.39 (4.13)	.622
Anger	8.55 (3.98)	7.70 (3.13)	.429
Anxiety	10.32 (4.41)	8.52 (3.99)	.159

COMOSWB = Concise Measure of Subjective Well-Being, MBI = Mibyeong Index, MMT = mobile mindfulness training, PSS = Perceived Stress Scale, WLC = wait-list control.

Table 3
The mean (SD) of PSS, COMOSWB, and MBI in 2 groups.

	MMT (n = 22)		B–A (MMT) paired t test		WLC (n = 23)		B–A (WLC) paired t test		RM ANOVA Group \times Time	
	Baseline (A)	Post (B)	P	d	Baseline (A)	Post (B)	P	d	P	η^2
PSS	28.05 (4.87)	26.95 (4.29)	.229	0.27	27.30 (4.06)	28.38 (4.55)	.189	0.28	.074	0.072
COMOSWB	38.91 (7.12)	42.40 (8.05)	.019	0.54	41.87 (5.07)	41.16 (9.63)	.643	0.10	.046	0.090
MBI	67.18 (18.05)	53.86 (18.10)	<.001	0.82	63.61 (20.76)	67.29 (25.39)	.335	0.21	.002	0.206
Fatigue	11.91 (4.17)	10.55 (4.00)	.094	0.37	12.39 (3.12)	12.95 (3.09)	.414	0.18	.067	0.076
Pain	9.09 (3.93)	7.59 (3.91)	.157	0.31	9.52 (4.93)	10.21 (4.97)	.548	0.13	.160	0.045
Sleep disturbance	9.45 (5.05)	7.73 (4.42)	.059	0.42	9.04 (5.50)	8.88 (4.96)	.856	0.04	.209	0.036
Indigestion	8.77 (4.15)	6.59 (3.42)	.008	0.62	8.04 (3.25)	7.79 (4.25)	.733	0.07	.071	0.074
Depression	9.09 (5.26)	6.73 (4.10)	.024	0.52	8.39 (4.13)	9.00 (4.95)	.354	0.20	.014	0.133
Anger	8.55 (3.98)	6.59 (3.28)	.015	0.57	7.70 (3.13)	8.33 (3.81)	.388	0.18	.016	0.128
Anxiety	10.32 (4.41)	8.09 (4.74)	.009	0.61	8.52 (3.99)	10.14 (5.09)	.096	0.36	.003	0.189

COMOSWB = Concise Measure of Subjective Well-Being, MBI = Mibyeong Index, MMT = mobile mindfulness training, PSS = Perceived Stress Scale, RM ANOVA = repeated measures analysis of variance, WLC = wait-list control.

Table 4
The mean (SD) of PSS, COMOSWB, and MBI for the MMT at 3 time points.

	Baseline (A)	Post (B)	Follow-up (C)	C–A paired t test		C–B paired t test	
				P	d	P	d
PSS	28.05 (4.87)	26.95 (4.29)	27.00 (4.87)	.337	0.19	.958	0.01
COMOSWB	38.91 (7.12)	42.40 (8.05)	42.80 (8.12)	.025	0.51	.760	0.07
MBI	67.18 (18.05)	53.86 (18.10)	50.50 (15.98)	<.001	0.97	.301	0.23
Fatigue	11.91 (4.17)	10.55 (4.00)	10.05 (4.81)	.055	0.43	.439	0.17
Pain	9.09 (3.93)	7.59 (3.91)	8.09 (4.49)	.357	0.20	.629	0.10
Sleep disturbance	9.45 (5.05)	7.73 (4.42)	7.05 (4.84)	.011	0.59	.344	0.18
Indigestion	8.77 (4.15)	6.59 (3.42)	6.77 (3.98)	.128	0.34	.875	0.03
Depression	9.09 (5.26)	6.73 (4.10)	5.32 (2.68)	.002	0.77	.083	0.39
Anger	8.55 (3.98)	6.59 (3.28)	5.68 (2.30)	.001	0.79	.125	0.34
Anxiety	10.32 (4.41)	8.09 (4.74)	7.55 (3.86)	.006	0.66	.504	0.14

COMOSWB = Concise Measure of Subjective Well-Being, MBI = Mibyeong Index, MMT = mobile mindfulness training, PSS = Perceived Stress Scale.

and anxiety. The paired *t* test revealed that MMT significantly reduced depression, anger, and anxiety in T3 compared with T1 (depression: $t(21) = 3.60, P = .002$; anger: $t(21) = 3.70, P = .001$; anxiety: $t(21) = 3.07, P = .006$). In contrast, the differences between T2 and T3 in depression, anger, and anxiety were not significant ($P_s > .083$). This suggests that the 4-week MMT not only improved depression, anger, and anxiety but also maintained improved symptoms until 4 weeks later. The results and statistical analyses are presented in Tables 3 and 4.

4. Discussion

Health is defined not only as the absence of disease, but also as the prevention of disease and promotion of well-being. Stress negatively affects personal health, but also lowers job motivation and performance, which in turn reduces organizational efficiency and productivity.^[2] Mibyeong is a condition that is not diagnosed as a specific disease but shows clear abnormal symptoms in the body, which is a stage before the development of a disease.^[11,12] Mibyeong directly affects the quality of life and potentially acts as a risk factor for various chronic diseases. Happiness and life satisfaction can prevent physical and psychological diseases among employees and improve their job performance. Therefore, companies have recently become increasingly interested in the stress and well-being of their employees, and many interventions to manage their mental health are emerging.^[7]

Recently, various mobile healthcare applications have been developed to promote health.^[14] Mindfulness is included as the core content of these healthcare applications (e.g., Headspace and Calm) and is used to improve psychological symptoms such as depression and anxiety and to promote well-being.^[18,28–31] However, most RCT studies on the effectiveness of MMT target students and the general public, and there are relatively few RCT studies on employees.^[18] Moreover, previous studies on employees are limited in that they did not deal with holistic health, such as disease prevention and happiness promotion.^[32,33]

This RCT investigated the effects of MMT on employees' mental health. Mental health means not only the absence of psychological distress but also the prevention of disease and promotion of well-being. The findings showed that a 4-week MMT improved subjective well-being and reduced Mibyeong symptoms, such as depression, anger, and anxiety. These findings are consistent with previous findings showing that mindfulness helps reduce psychological symptoms and improve subjective well-being.^[21,24] In addition, improved subjective well-being and Mibyeong were maintained up to at least 4 weeks after the completion of MMT. These results are consistent with previous studies showing that the effects of mindfulness meditation on mental health could be long lasting.^[39,40] Grossman et al^[39] found that mindfulness training improved quality of life, depression, and fatigue, and that the effect was maintained for up to 6 months. Similarly, Kosugi et al^[40] found that 8-week mindfulness-based cognitive therapy improved the subjective well-being of healthy people, and that this effect was maintained for up to 2 months.

In contrast, the 4-week MMT did not significantly improve perceived stress. This finding is inconsistent with previous studies' findings regarding mindfulness meditation positive effect on stress reduction.^[24,26] These results can be explained by the sample and training period duration. First, the effect of MMT on perceived stress may have been underestimated because this study used a sample of healthy employees. Second, the 4-week training period may have been too short for the effect of MMT on perceived stress to appear. Previous studies have shown that 4 weeks of MMT improves stress in the general public.^[35,36] However, considering that standardized mindfulness programs such as Mindfulness Based Stress Reduction typically run for 8 weeks, 4 weeks may be a short intervention period.

Considering that the group \times time interaction of repeated measures analysis of variance for perceived stress has a significant tendency, it may need to be further investigated in future clinical studies.

This study has several limitations. First, this study did not establish criteria for the diagnosis of participants' mental disorders and could not determine whether participants had mental disorders. Therefore, in future studies, the inclusion criteria for the diagnosis of mental disorders should be clearly established and clinical populations should be recruited. Second, there was no active control group, the inclusion of an active control group in a future study may show the effectiveness of MMT compared with other treatments. Third, the duration of MMT was not sufficiently long, which could lead to an effect too small to be noticed on the sample. If sufficient training is provided, the effect of MMT on perceived stress may be significant. Fourth, this study did not measure covariates such as education level, socioeconomic status, and participation in other wellness activities that could affect the findings. This makes it difficult to know whether random assignment was effective and whether the findings were not due to covariates. For example, the higher an individual's motivation for wellness is, the more likely they are to engage in other wellness activities, and the stronger the placebo effect on interventions is likely to be. Moreover, given that this study was not blinded, this placebo effect is likely to influence the findings.

5. Conclusion

According to the results of this study, 4 weeks of MMT improved the subjective well-being and Mibyeong of employees and this improvement was maintained for at least 4 weeks post intervention. Considering that smartphone-based interventions are not geographically constrained and can provide high-quality training at reduced economic costs,^[15] MMT might provide a cost-effective solution for employee mental health. However, further studies, such as analysis of economic impacts and large-scale studies, are needed.

Author contributions

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